Behavior and performance evaluation of µC/OS V3.03.01 on RX63N

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1 Document Intention

1.1 Purpose and scope

This document presents the quantitative evaluation results of the real-time µC/OS-III operating system from Real Time Engineers Ltd, which was evaluated on the Renesas RX63N microcontroller. The testing results of this operating system employed on an RX63N processor can be found on our website. (www.dedicated-systems.com)

The layout of this report follows the one depicted in "The OS evaluation template" [Doc. 4]. The test specifications can be found in "The evaluation test report definition" [Doc. 3]. For more detailed references, See section "Related documents" of this document. These documents have to be seen as an integral part of this report!

Due to the tightly coupling between these documents, the framework version of "The evaluation test report definition" has to match the framework version of this evaluation report (which is 2.9). More information about the documents and tests versions together with their corresponding relation between both can be found in "The evaluation framework", see [Doc. 1] in section "Related documents" of this document.

The generic test code used to perform these tests can be downloaded on our website by using the link in the related documents section.

1.2 Test framework used: 2.9

This document shows the test results in the scope of the evaluation framework 2.9. More details about this framework are found in Doc 1 (see section "Related documents").

1.3 Conventions

Throughout this document, we use certain typographical conventions to distinguish technical terms. Our used conventions are the following:

- ***Bold Italic*** for OS Objects
- **Bold** for Libraries, packets, directories, software, OSs...
- `Courier New` for system calls (APIs...)

2 Introduction

This chapter introduces: 1) The OS that we are going to test and evaluate, 2) the hardware platform on which the under testing OS and evaluation will perform, and 3) how to implement the evaluation adapted to µC/OS-III on the Renesas RX63N platform.

2.1 Overview

The evaluation project started from 1995 and as such accumulates a long experience with different (RT) OSs. µC/OS-III is a prevalent, well-developed, preemptive, and highly efficient real time operating system that supports more than 34 embedded system architectures. However, it can't be used in commercial products without any Licensing fee.

µC/OS-III provides many official example applications that are specially ported on specific hardware platforms. This report is based upon the YLCDRX63N evaluation board which includes a Renesas RX63N microcontroller. The whole evaluation test was carried by using the Renesas CC-RX Compiler V2.01.00, together with e2 Studio IDE V2.2.0.13.

In order to keep consistency with previous evaluations on different platforms, thread and task are mutually used in this document, and they have the same meaning.

A simultaneous evaluation of µC/OS-III has also been done which you can find in "Behavior and performance evaluation of FreeRTOS 8.0.0 on RX63N" [Doc. 5]. So, in order to provide a better view for the reader, some comparison comments are given all along this document.

2.2 Evaluated (RTOS) product

This section describes the OS that Dedicated Systems tested using their Evaluation Testing Suite, and the hardware on which this OS was running during the testing. In addition, it explains how to implement the evaluation.

2.2.1 Software

µC/OS-III v3.03.01, being the latest version at the time of doing the evaluation, is tested here. µC/OS-III uses preemptive task scheduling policy supporting unlimited number of tasks (of course limited by the memory available). For tasks with the same priority, Round-Robin policy is optional to use at runtime. µC/OS-III supports queues, binary semaphores, counting semaphores, task semaphores, and mutexes with priority inheritance for critical recourse access and sharing between tasks.

The evaluation for its significant features, such as mutex, semaphore, and tasks, is performed using several performance and behavior tests. The testing results are applicable only to this version as other versions may have other significant performance figures and behavior.

For tasks, µC/OS-III provides native APIs to use system functions without providing any standard interfaces, such as POSIX calls. Furthermore, in order to get the accurate measurements, we decided to use two 16-bit on-chip multi-function timers (MTU2) to assemble a 32-bit timer running at 48MHz, which is accurate enough compared to the frequency of processor.

2.2.2 Hardware

µC/OS-III v3.03.01 is tested on a Renesas RX63N-based platform with the following characteristics:

- 100MHz 32-bit Renesas Rx63N MCU without cache;
- On Chip Memory: 128KB RAM, 2MB FLASH;
- On Module Memory: 16MB RAM, 16MB serial FLASH;
- Four on-chip 8-bit timers (TMR), four on-chip 16-bit compare match timers (CMT) and six 16-bit on-chip multi-function timers (MTU2).

2.2.3 Evaluation Implementation

In order to execute our tests, it is necessary to port the evaluation code into µC/OS-III. We use Renesas CC-RX Compiler V2.01.00 and e2 Studio IDE V2.2.0.13 as the development environment. The binary executable file is transferred into the evaluation board by using J-Link.

3 Evaluation results summary

Following is a summary of the results of evaluating µC/OS-III v3.03.01 on Renesas RX63N MCU.

3.1 Positive points

- Source code of kernel available.
- Including a lot of BSPs.
- Very easy to install and run from the example projects included in a BSP.
- The kernel is highly configurable.

3.2 Negative points

- The behavior of function `OSTaskChangePrio()` is not implemented correctly (***See 4.3.1***).
- The official documents and source code of BSP are not for free.
- Although there are some good BSPs, setting up a complete embedded target from scratch is a daunting task.

3.3 Ratings

For a description of the ratings, see [Doc. 3].

RTOS Architecture	0	8	10
OS Documentation	0	4	10
OS Configuration	0	8	10
Internet Components	0	4	10
Development Tools	0	6	10
Installation and BSP	0	8	10
Test Results	0	7	10
Support	0	4	10

Although [Doc. 3] gives a description of the ratings, comparison with other reports on other OS should help you understand the scoring.